

Systematics and Biogeography of New World Pentatomoidea (Hemiptera: Heteroptera)

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Abstract. This paper provides an overview of the systematics and zoogeography of the superfamily Pentatomoidea in the New World. Characters are given to help distinguish the major groups.

Introduction

The superfamily **Pentatomoidea** is worldwide in distribution and contains a number of pest and beneficial species. These bugs are significant pests of many crops including cotton, *Gossypium hirsutum* L., soybean, *Glycine max* Merrill, rice, *Oryza sativa* L., wheat, *Triticum aestivum* L., etc. (Schaefer y Panizzi 2000) and some are predaceous on pest insects. Recently there have been several introductions of Old World species into the New World. *Halyomorpha halys* (Stål), an Asian species, was introduced into the northeastern United States probably around 1996 (Hoebeke & Carter 2003). Since then it has spread considerably and is a serious crop and home invading pest. *Bagrada hilaris* (Burmeister), also from Asia, was first found in California in 2008 and has become an important pest of crucifers in the southwestern United States (Palumbo y Natwick 2010). In 2009, another Asian species from a family not previously known in the Western Hemisphere (Plataspidae) was found in the southeastern United States and has become a pest of soybean as well as a significant home invader (Eger *et al.* 2010; Gardner *et al.* 2013). An understanding of the systematics of this important group is needed to recognize future invasive bugs so that we can research known control methods and access potential natural enemies for classical biological control efforts.

The purpose of this paper is to review the higher classification of Pentatomoidea known from the Americas and discuss their zoogeography.

Systematics and zoogeography

Schuh and Slater (1995) provided an overview of the classification of world Heteroptera with keys to superfamilies and families. The Pentatomoidea of the New World consists of 12 families, one of which (Plataspidae) has been introduced from the Old World. Kirkaldy (1909) provided a catalog to many of the families of Pentatomoidea and Rolston and McDonald (1979) provided a

key to families, subfamilies of Pentatomidae, and tribes of Pentatominae. Four of the families, Canopidae, Cyrtocoridae, Megarididae, and Phloeidae, are found only in the New World and all of these four represent endemic taxa to the Neotropical Region. I'll discuss these endemic families first.

The **Phloeidae** are large flat bugs with 3-segmented antennae and 3-segmented tarsi. The outer margins of the juga, pronotum, abdomen and base of the hemelytra are broadly foliate. The eyes are divided into dorsal and ventral parts. They are found on the trunks of trees where they are well camouflaged. The distribution of phloeids is primarily in the Amazon basin and the Atlantic forests of Brazil and French Guiana. Leston (1953) provides a review of the family with keys to genera and species.

Cyrtocoridae can be recognized by the 2-segmented tarsi, 5-segmented antennae, and an elevated spine or hump in the middle of the scutellum. The body is rough and setose and provided with waxy granules. Cyrtocorids are found from Mexico to Argentina and are considered by some authors to be a subfamily of the Pentatomidae. The family was revised by Packauskas and Schaefer (1998).

The families **Canopidae** and **Megarididae** are small black bugs rarely with colored markings. Their bodies are almost round with an enlarged scutellum that covers most of the forewings and reaches the end of the abdomen. In both families the forewings fold up under the scutellum and the intersegmental sutures on the abdominal venter become obsolete before reaching the edge of the abdomen. Megaridids differ from canopids in having 2-segmented tarsi and 4-segmented antennae which possess elongate setae which may be as long as the antennal segments. Canopids have 3-segmented tarsi and 5-segmented antennae which are provided with short setae, not as long as the diameter of the antennal segments. McAtee and Malloch (1928) revised the two families and McDonald (1979) added a new species of Megaris and reviewed the genitalia. These two families are found in the Neotropical Region.

The **Thyreocoridae** are small black bugs, frequently with some pale markings. They have an enlarged or U-shaped scutellum, tibiae are provided with stout spines, antennae are 5-segmented, and tarsi are 3-segmented. They resemble the Cydnidae and have been considered to be a subfamily of the Cydnidae by some authors, but their fore tibiae are cylindrical whereas the fore tibiae of cydnids are flattened or cultrate with tibiae inserted mesially. There are two subfamilies, Thyreocorinae and Corimelaeninae. The former is Old World in distribution and includes only 3 genera and 8 species. The Corimelaeninae are distributed throughout North and South America and the subfamily contains about 9 genera and 200 species. The family was revised by McAtee and Malloch (1933).

Acanthosomatidae have 2-segmented tarsi and usually have 5-segmented antennae. They are distinctive in having one or two pairs of Pendergrast's organs (depressed oval to elongate structures on segments 5-7 of females) and the 8th sternite in males is large and exposed. There are three subfamilies, all of which occur in the New World. The Acanthosomatinae are distributed in most major zoogeographic regions, but are limited to North America in the New World and

show affinities with Holarctic genera. The other subfamilies, Blaudusinae and Ditomotarsinae demonstrate Gondwana distribution patterns with taxa found in southern South America, Southern Africa and Australia. In the New World, Chile has the largest number of acanthosomatids, many of them endemic and they extend northward, mainly at higher altitudes in the Andes. Kumar (1974) revised the world genera and Rolston and Kumar (1974) provided a key to American genera, two of them new. Thomas (1991) revised the North American taxa.

Dinidoridae are primarily Old World bugs with those of the New World belonging to a single genus, *Dinidor* Latrielle. There are two subfamilies, Dinidorinae and Megymeninae. New World dinidorids are relatively large, have 3-segmented tarsi, 4-segmented antennae, and can be distinguished by having both trichobothria on abdominal segments 3-7 located in pale calli which are located mesad and posterior to the spiracles. Dinidorids are primarily distributed in the Oriental and Ethiopian regions with *Dinidor* spp. found in the Neotropical Region. Durai (1987) revised the family.

Tessaratomidae are similar to dinidorids in being primarily an Old World family with a single genus, *Piezosternum* Amyot & Serville, in the New World. American species can be recognized by large size, 3-segmented tarsi, 5-segmented antennae, and the pronotum expanded over the anterior portion of the scutellum. There are three subfamilies of Tessaratomidae. Naticolinae are found primarily in the Ethiopian Region, Tessaratominae are widely distributed in the Old World, and Oncomerinae contains taxa in the Oriental and African Regions and includes *Piezosternum* in the Neotropical Region. There are three species of *Piezosternum* in the Neotropical Region and several congeners in Africa. Leston (1955) provided a key to genera of Oncomerini.

The family **Cydnidae** are unusual pentatomoids in that they are typically burrowing bugs and have legs that are adapted for digging. They can be recognized by having a series of stout spines on the anterior tibiae and the tibiae modified for digging, either expanded or cultrate with the tarsi inserted halfway down the tibiae. These are also usually black or brown bugs without other markings. Antennae are usually 5-segmented and tarsi 3-segmented. Dolling (1981) revised the higher level classification of this family and included as subfamilies of Cydnidae a number of groups previously considered to be distinct families. I have chosen not to follow Dolling in considering Thyreocoridae and Corimelaenidae as subfamilies of Cydnidae. With these families removed, Cydnidae consists of 6 subfamilies, 4 of which occur in the New World. Amnestinae are endemic to the Americas although one species has been introduced into the Middle East. Scaptocorinae consists of a single genus found in the Neotropical Region and two genera found in the Oriental and Palearctic Regions. Sehirinae are most diverse in the Palearctic Region with some taxa in the Oriental and Ethiopian Regions. It is represented in the New World by a single North American species of the predominately Palearctic genus *Sehirus* Amyot & Serville. The nominate subfamily, Cydninae, are the most diverse, being present in all of the major zoogeographical regions. Froeschner (1960) revised the American fauna. Mayorga (2002) reviewed the Mexican fauna.

Scutelleridae are characterized by an enlarged scutellum which covers most of the abdomen and wings, strongly biconcave body, intersegmental sutures on the abdominal venter reaching the lateral margin of the abdomen, and frenum reduced or absent. They usually have 5 antennal segments and 3 tarsal segments. Scutellerids are found in all major zoogeographical regions. There is considerable disagreement about the number of subfamilies which range from four to eight or more. The Pachycorinae are exclusively American and are the most diverse group in the New World. They are characterized by stridulatory patches on the abdomen and the subfamily previously contained two genera from Africa and one from Australia which possessed similar stridulatory patches. McDonald and Cassis (1984) erected the subfamily Tectocorinae for the Australian genus *Tectocoris* Hahn while the African pachycorines were placed into a new subfamily, Hoteinae, by Carapezza (2009). Pachycorinae are most diverse in the Neotropical Region but are well represented in the Nearctic. The nominate subfamily Scutellerinae is represented by single genus in the New World, *Augocoris* Burmeister. These bugs are large, colorful and easily recognized by having 3-segmented antennae. They appear to be closely related to the African genus *Cryptacrus* Mayr. The Eurygasterinae have a somewhat reduced and parallel-sided scutellum that leaves the hemelytra exposed for much of their length. This Holarctic subfamily contains major pests in the Palearctic and Ethiopian regions. Four non-pest species are present in North America. Finally, the Odontotarsinae are small dull colored bugs which are Holarctic but most diverse in the Palearctic Region. They occur in the Americas only in North America where they are chiefly western in distribution. There are a few representatives in the Australian region. Schouteden (1904) provided the most recent keys for Neotropical American taxa. Lattin (1964) revised the species occurring north of Mexico in an unpublished dissertation.

The **Pentatomidae** are, by far, the largest family in the Pentatomoidea and occur in all zoogeographical areas. They can be characterized as having a relatively flat and usually not enlarged scutellum, metathoracic scent gland ostiole not opening near lateral margin of the segment, abdominal trichobothria not on large pale callus, pronotum not extending over base of scutellum, spines on tibiae confined to apex if present, sternite 8 in males not exposed, Pendergrast's organs not present in females, and tarsi usually 3-segmented, antennae usually 5-segmented. Rolston and McDonald (1979) provided keys and diagnoses for the five New World subfamilies. The Asopinae are predaceous bugs characterized by a thickened rostrum which does not lie between the bucculae. Thomas (1992) revised the New World genera and species providing keys to all taxa. Podopinae are also global in distribution and are recognized by the enlarged scutellum, dull coloration and the presence of only a single trichobothrium on each side of abdominal segments. Barber and Sailer (1953) revised the North American taxa and Kormilev and Piran (1952) added one species from Argentina. The nominate subfamily, Pentatominae, has paired trichobothria, rostrum not thickened and usually lying between bucculae, labium arising behind the level of the anterior margin of the eyes, and metasternum not produced anteriorly onto mesosternum. Rolston and McDonald (1979) provided keys and diagnoses for recognition of the tribes of Pentatominae, but tribal relationships have been greatly modified since their work.

Rolston *et al.* (1980) and Rolston and McDonald (1981, 1984) provided keys to many of the genera. Pentatominae is a very large subfamily and there are good revisions of many of the included genera but these are too numerous to list here. The three subfamilies treated above are found in all zoogeographic regions, while the remaining two are unique to the New World. The Edessinae are generally large bugs and can be recognized by the enlarged metasternum which is produced anteriorly over the mesosternum and sometimes onto the prosternum. These are primarily Neotropical bugs with only two species reaching the southern United States. Most species are placed in a single genus, *Edessa* Fabricius, which is in need of revision. There have been a few recent papers that deal with species groups of *Edessa* or smaller genera, but no comprehensive treatment of the subfamily. The final American subfamily, Discocephalinae, is characterized as having paired trichobothria, the one closest to the spiracle on abdominal segment 7 positioned laterad of a line connecting spiracles by the width of a spiracle or the labium arising behind a line connecting the anterior margins of the eyes. There are two tribes, Discocephalini and Ochlerini. Rolston (1990, 1992) provided keys to the 'broad-headed' Discocephalini and to the Ochlerini.

The last family that I'll address briefly is the **Plataspidae**. These are Old World bugs not present in the New World until recently. In 2009, *Megacopta cribraria* (Fabricius) was found in the United States in Georgia, and has spread to an area ranging from Virginia to Florida and west to Mississippi (Eger *et al.* 2010; Gardner *et al.* 2013). These bugs can be recognized by the presence of 2-segmented tarsi, enlarged scutellum, flat venter, and 5-segmented antennae.

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